HIGH-PRECISION ION-MICROPROBE U-Pb AGES ON 325 ka GRANITOIDS INTRUDED BENEATH AN ACTIVE VOLCANO: MEDICINE LAKE, CALIFORNIA. J. B. Lowenstern, J. L. Wooden and J. Donnelly-Nolan (all at: U.S. Geological Survey, Mail Stop 910, 345 Middlefield Road, Menlo Park, CA 94025, USA; jlwnstrn@usgs.gov).

Introduction: Using the Stanford-USGS SHRIMP-RG, we obtained U-Pb ages on zircons separated from young granodiorites obtained from: 1) geothermal drillcore, and 2) a xenolith in a Pleistocene pyroclastic flow, all from Medicine Lake volcano (MLV), northern CA, which last erupted 900 years ago. Such samples reveal the history of silicic plutonism beneath the volcano and afford insight into the relationship between intrusions, volcanism and the genesis of a high-temperature geothermal system.

Methods: Ions were sputtered from zircons with a 10.5 nA primary O_2^- beam focused to a 30μm-round spot. To minimize contamination by common Pb, the grain mount was cleaned in 1 N HCl acid for 5 minutes and the primary beam was rastered for 240 s on a 150-μm^2 region prior to data acquisition. The mass spectrometer was cycled eight times through peaks corresponding to Zr_2O, ^{204}Pb, background, ^{206}Pb, ^{207}Pb, ^{208}Pb, ^{238}U, $^{232}Th^{16}O$ and $^{238}U^{16}O$.

High-Precision U-Pb Ages: A hydrothermally altered granodiorite xenolith (sample 997M-f; 67 wt.% SiO_2; $\delta^{18}O$ = +0.5 per mil) found within the ~180 ka Andesite Tuff yielded zircons with 1000 to 9400 ppm U and Th/U varying from 0.83 to 1.57. The high U contents, combined with minimal common Pb allowed for very low $^{207}Pb/^{206}Pb$ ratios (0.04 - 0.10). Not accounting for initial $^{230}Th/^{238}U$ disequilibrium, the ^{207}Pb-corrected ages for 10 analyzed spots range from 240 to 280 ka. The combined data have a weighted mean age of 254±9 ka (2σ). Using Isoplot [1], a line fit through the uncorrected data on a conventional Tera-Wasserburg diagram, and anchored to the whole-rock $^{207}Pb/^{206}Pb$ of 0.82, yields an age of 252±10 ka (2σ). The age is the same as that of an altered granodiorite obtained from geothermal drillcore at MLV (sample 31-17; recovered at ~2.5 km depths; see Fig. 1) and discussed in [2]. The U-Pb data for the two rocks can be fit by a line leading from $^{207}Pb/^{206}Pb$ of the whole rock to a point on concordia corresponding to an age of 252±9 ka (2σ). Such precision is equivalent to that of Ar-Ar and K-Ar geochronology, but is also noteworthy because the rocks are hydrothermally altered, and yield poor-quality Ar-Ar age spectra [2].

Initial Disequilibrium: The U-Pb ages must be adjusted for initial $^{230}Th/^{238}U$ disequilibrium caused by U/Th fractionation during zircon growth. Initial $(^{230}Th/^{238}U)$ can be estimated from the mean $(^{238}U/^{232}Th)$ values obtained during U-Th analyses with SHRIMP-RG. U-Th data for zircons from 997M-f and 31-17 lie astride the equiline with $(^{238}U/^{232}Th)$ ranging from 2.0 to 4.5. Taking the average value of 3.0, and assuming $(^{230}Th/^{232}Th)_i$ =1, $(^{230}Th/^{238}U)_i$ would be 0.33. Using the method of [3] and assuming $(^{234}U/^{238}U)$=1, the best fit to the data intercepts a modified concordia at 323 ka. The maximum U/Th of the zircons would correspond to a slightly older age of 335 ka. Accounting for analytical uncertainty and U/Th fractionation, both rocks crystallized at 323±9 ka (2 σ).

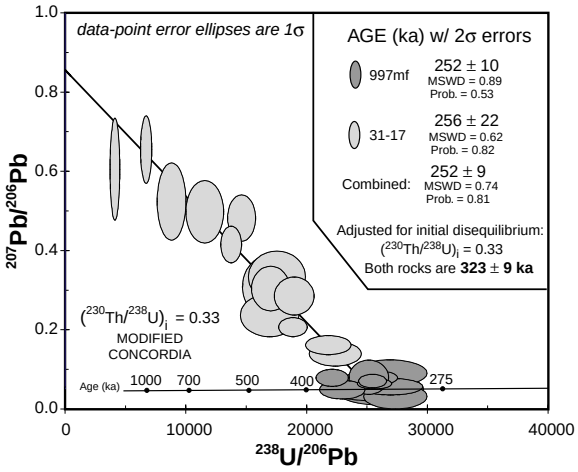

Fig. 1. Tera-Wasserburg plot with concordia adjusted for initial U-Th disequilibrium.

Implications for MLV: Discovery of a xenolith with an identical age to hydrothermally altered granodiorite recovered from within the hydrothermal system has significant implications for the history of MLV and its geothermal system. First, alteration associated with the genesis of the geothermal system had begun prior to 180 ka, the eruption age of the xenolith-bearing Andesite Tuff. Second, the Andesite Tuff magma apparently resided within the shallow crust, dislodged a number of xenoliths from this granodiorite intrusion, and assimilated low $\delta^{18}O$ materials [4]. In contrast, granitoid xenoliths from most late-Pleistocene and Holocene lavas at MLV are younger and unaltered, and were likely incorporated into magmas derived from below the hydrothermal system, thus at greater depth than earlier eruptions.

References: [1] Ludwig K. R. (1999) Isoplot/Ex Version #2.05, *Berkeley Geochronology Center Special Publication No. 1a.* [2] Lowenstern, J.B. et al. (1999) *Eos, Trans. AGU., 80*, F1130. [3] Wendt I. And Carl C. (1985) *Earth Planet. Sci. Lett. 73*, 278—284. [4] Donnelly-Nolan, J. (1998) *Bull. Volcanol. 59*, 529-536.